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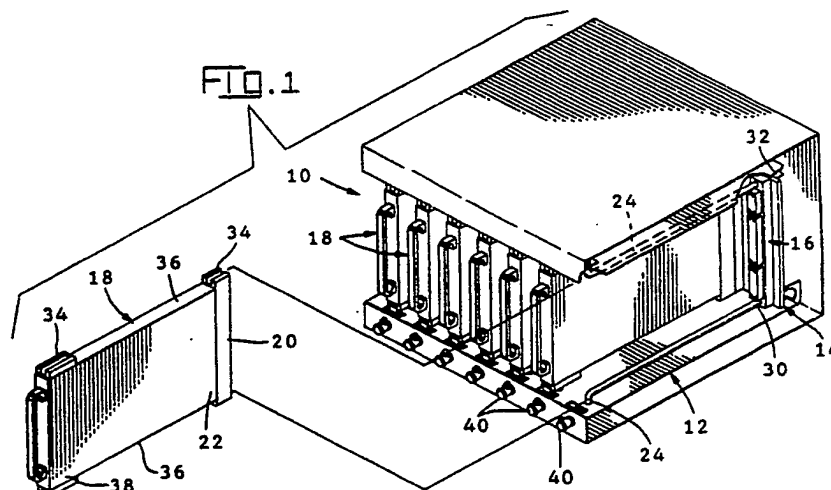
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(54) Alignment system for line replaceable modules

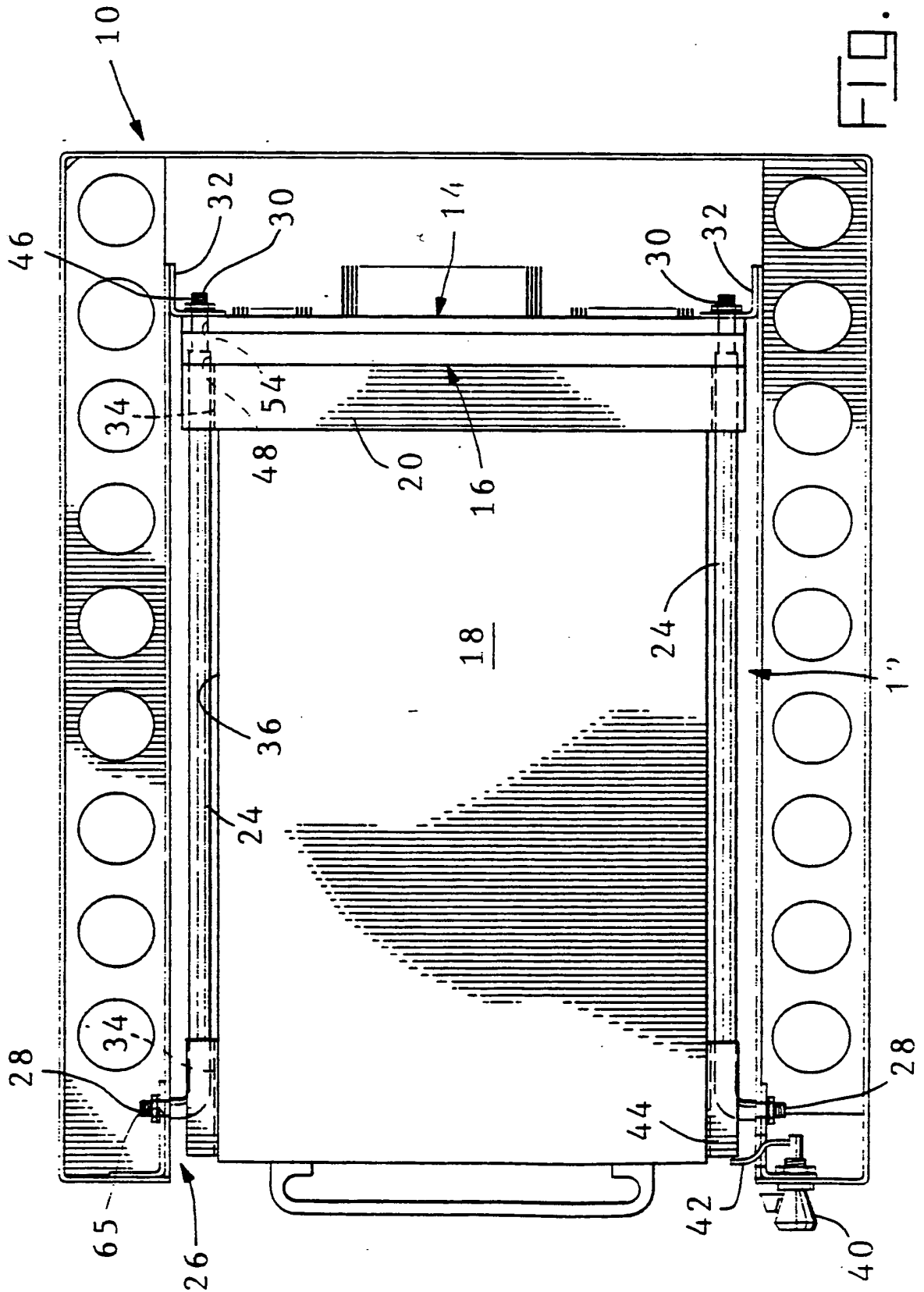
(57) A pair of track members (24) is fastened to a framework (12) of a black box (10) forwardly of each mother board connector (16) of an array thereof mounted on the mother board (14) of the black box (10). The track members (24) extend forwardly in parallel from end flanges of the connector (16) to leading ends fastened to the black box framework (12) at the LRM-receiving front aperture, so that an LRM (18) placed between the pair of tracks (24) is movable to the mother board connector (16) for mating of the LRM connector (20) therewith. The trailing ends (30) of the track members (24) extend through precisely located holes through the end flanges of the mother board connector (16) and through the mother board (14) after which the end portions (30) are fastened to frame members (32) behind the mother board (14). The track members (24) can be hollow enabling fluid to be circulated therethrough to dissipate heat from the LRM (18). The track members (24) can constitute the means to fasten the mother board connector (16) to the mother board (14), and also the mother board (14) to the framework (12) of the black box (10).



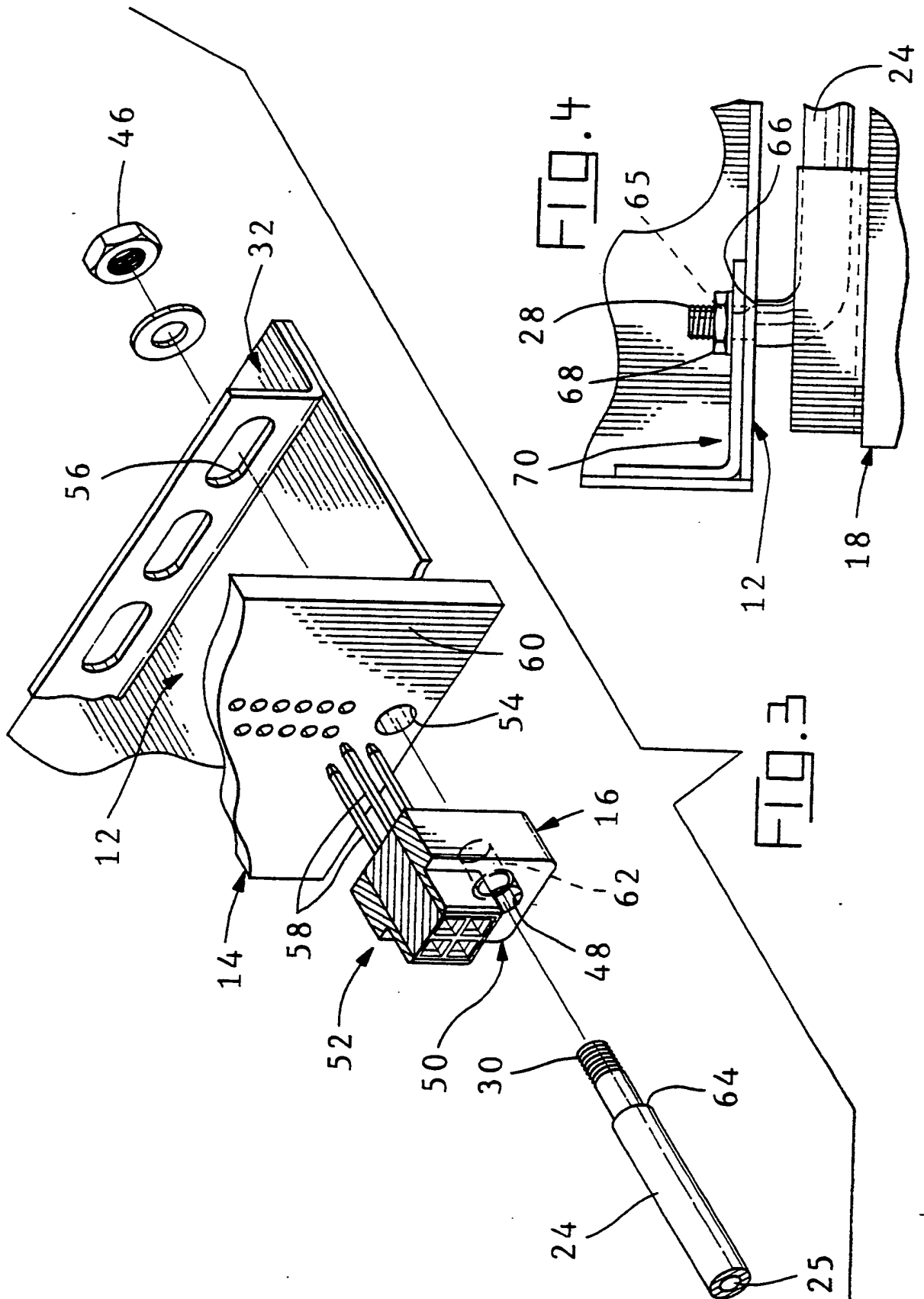
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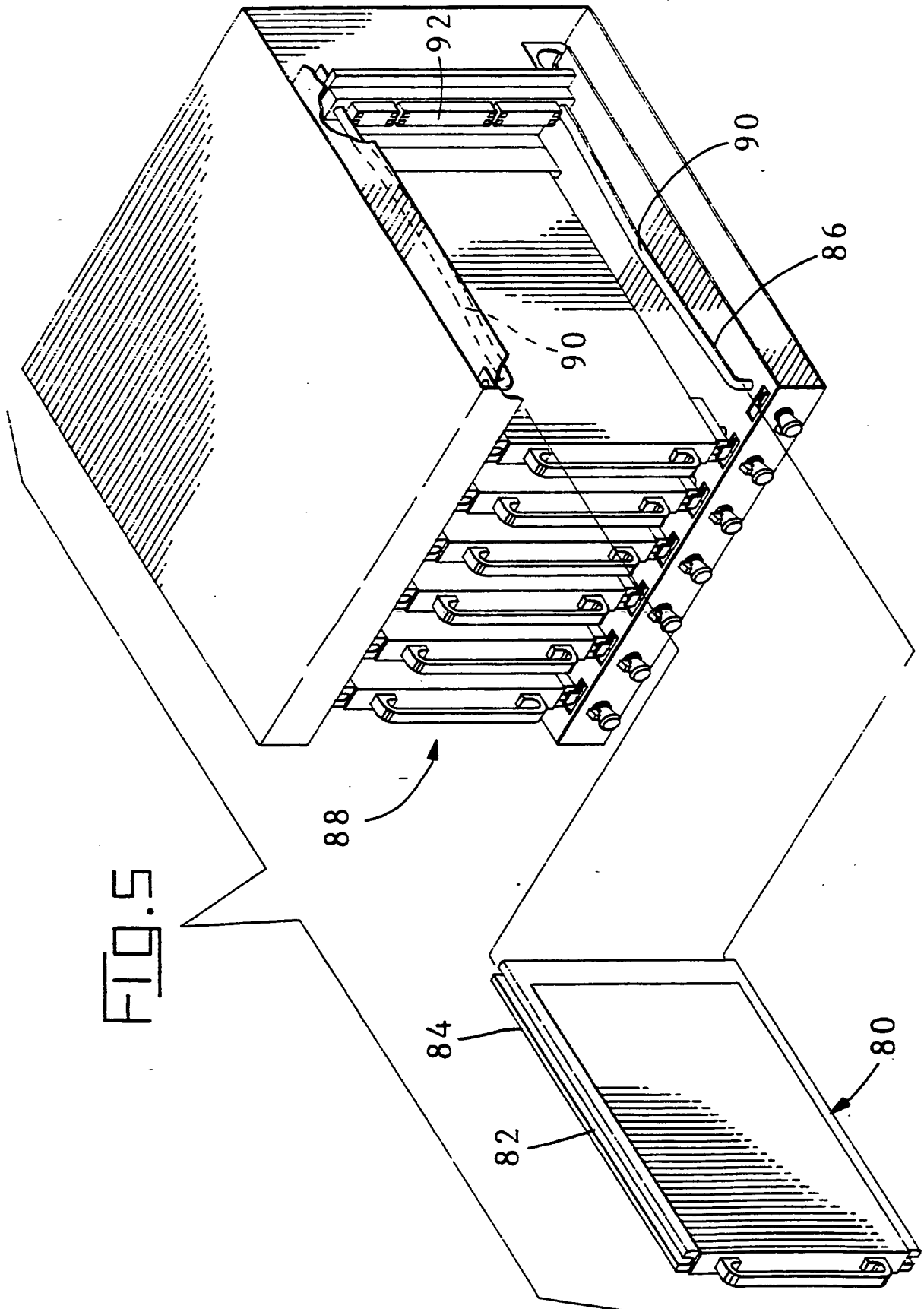


FIG. 2



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ALIGNMENT SYSTEM FOR LINE REPLACEABLE MODULES

1 The present invention relates to the mating of
electrical connectors and more particularly to aligning of
connectors for proper mating.

 Especially in the aircraft industry, it is becoming
5 desirable that electronic control units, or "black boxes,"
each comprise a housing containing essentially a single
circuit panel or mother board to which are electrically
connectable a plurality of line replaceable modules on one
surface and shipboard electrical systems on the other.
10 Each line replaceable module, or LRM, performs a control
or sensing or recording function and comprises essentially
one or more circuit cards or daughter boards loaded with
various electrical and electronic components, mounted to a
heat sink plate and protected and shielded by cover
15 plates. The LRM is intended to be a durable, rugged
assembly capable of being handled and repeatedly inserted
into and removed from a black box for testing, repair,
modification or replacement

 The plurality of LRM's are closely spaced in a side
20 by side array within the black box and along the mother
board; and each LRM has a small dimension along the array
to facilitate such close spacing. The daughter card or
cards and all of the electrical and electronic components
connected thereto necessary in the LRM are secured to a
25 heat sink plate disposed essentially along a plane
transverse to the array of LRM's and extending rearwardly
from the LRM connector at the forward end of the LRM, so
that the LRM is long rearwardly and is wide transverse to
the array. The electrical connector mounted on the
30 forward end thereof has a mating face exposed to mate with
the mating face of a corresponding one of a plurality of
electrical connectors secured on the mother board mounted
within the black box in a closely spaced array for
efficient use of the real estate of the mother board. The

1 black box must be provided with guiding means along
opposing side walls extending from the LRM-receiving
opening to each mother board connector, to guide the long
and wide LRM into lateral and axial alignment with the
5 respective mother board connector for proper aligned
mating of the connectors.

In one particular design of black box the guide means
for each LRM comprises a pair of opposed channels formed
in and along surfaces of plate members mounted along the
10 side walls of the black box, and the cover plates of each
LRM form a flange along each of its opposed side edges to
be disposed in the guide channels therefor. The LRM
flange is dimensioned just thin enough to permit movement
along the channel without permitting side to side
15 movement, for vibration resistance. Due to practical
considerations the mother board with its precisely located
circuitry cannot be mounted in the black box in such a way
that its connectors are precisely aligned with the
channels associated therewith which are already formed in
20 the plate members of the black box. Therefore, the
channel locations are not particularly precisely located
with respect to the mother board connectors; the LRM
flanges are constrained to move therealong which results
in the LRM also being not particularly precisely aligned
25 with the respective mother board connector. As a result,
for this particular black box design either the mother
board connector or the LRM connector must be capable of
incremental lateral movement during mating to provide
precise alignment of their terminals prior to terminal
30 engagement.

Rack and panel or drawer connectors are known wherein
one of a mating pair includes integral alignment posts
extending forwardly therefrom to enter corresponding
apertures of the other, for connector self-aligning during
35 mating. At least one of the mating connectors is float

1 mounted either on a panel or on framework or a panel at
the leading end of the drawer by shoulder screws through
enlarged diameter holes through connector flanges,
enabling incremental lateral movement caused by bearing
5 engagement of the alignment posts and apertures. Such a
connector is the METRIMATE Drawer Connector (trademark of
AMP Incorporated, Harrisburg, Pennsylvania); another is
disclosed in U.S. Patent No. 4,647,130; and in both the
connectors contain terminals terminated to discrete
10 conductors. However, the float mounting means of the
prior art drawer connectors is not particularly suitable
for either the mother board connector or the LRM
connector, which in turn means that the alignment post and
aperture arrangement thereof also is not suitable for use
15 with LRM's.

Mother board connectors in the black box must be
fixedly mounted to the mother board to protect the
terminations of those of its terminals which are soldered
to circuit paths of the board, and the LRM connector must
20 be secured well enough to and within the cover plates of
the LRM to protect the terminations of those of its
terminals which are soldered to circuit paths of daughter
cards fixedly secured to heat sink plates within the LRM.
Each mating pair of the plurality of electrical terminals
25 of the connectors across their mating faces must be
precisely aligned to establish respective electrical
connections therebetween; the connectors may also have
optical fiber connectors similarly requiring precise
alignment for establishing optical connections. One type
30 of high density connector which can be adapted for use in
an LRM is disclosed in U.S. Patent No. 4,715,829.

The terminal housing means of the LRM connector may
be recessed within a shroud at the forward end of the LRM
and secured within the cover plates against axial movement
35 but permitted incremental lateral movement within a

1 peripheral gap around the inside shroud surface. An
alignment rib can extend forwardly from the LRM connector
housing means to enter a corresponding aperture in the
mother board connector, and upon bearing engagement urge
5 the LRM connector housing means incrementally laterally to
align therewith.

It is desired to provide a guide means which is
particularly precisely located and aligned with respect to
the particular mother board connector with which the
10 connector of an LRM is to mate, whereby the LRM is itself
particularly precisely aligned with the mother board
connector, and the connector housing of the LRM need not
move incrementally within the LRM to align with the mother
board connector, permitting an LRM of simpler construction
15 and assembly.

According to the present invention, the guide means
for each LRM comprises a pair of opposed tracks or rails
secured to the framework of the black box and extending
from the LRM-receiving opening thereof to the respective
20 mother board connector mounted on the mother board secured
within the black box. The LRM includes channel portions
along opposed sides thereof within which the tracks are
disposed enabling the LRM to follow the tracks during
insertion into the black box. The end of each track at
25 the mother board connector extends through a hole through
an end flange of the connector, through a hole of the
mother board aligned with the flange hole, and through a
larger hole or slot of the frame member of the black box.
The hole through the connector flange is precisely located
30 with respect to the terminals thereof and is precisely
dimensioned to just allow the track end to be inserted
therethrough without allowing the track to move laterally
therein.

1 The track is assembled to the black box by its
connector end being inserted through the connector flange
hole which precisely locates the track with respect to the
connector, only after which is the connector end secured
5 to the frame such as by a nut threaded onto the portion of
the track end extending through the frame member. The
other end of the track is secured at the LRM-receiving
opening to a frame member of the black box, and can
comprise a portion extending at a right angle outwardly to
10 a stop shoulder and therepast through a hole of the frame
member to a threaded end portion onto which a nut is
secured. The stop shoulder engaging the inwardly facing
surface of the frame member positions the track
appropriately into the central portion of the black box to
15 center the LRM. The track being as long as the LRM, any
incremental angle with respect to the mother board
connector caused by the other track end being secured in a
frame member hole which is not very precisely located with
respect to the mother board connector, is insignificant in
20 its effect on axial alignment of the LRM and the LRM
connector with the mother board connector.

 According to another aspect of the present invention,
the track can be a tube made of a metal alloy selected for
its high heat conductivity and for spring characteristics.
25 The track can be formed with a slight inward arcuate
configuration along its length, so that during insertion
of an LRM therealong the pair of tracks are deflected
outwardly by the bottoms of the respective LRM channels
and remain deflected applying spring bias against the
30 channel bottoms assuring substantial surface contact
therewith and thereby assuring a good thermal connection.

 The tubular tracks can be connected to a coolant
system, and their tubular nature enables fluid to be
pumped therethrough. This arrangement enables the tracks
35 to participate in conducting heat away from the LRM during

1 in-service use, and also can hold the side of the LRM away
from the black box framework to facilitate air flow
therearound.

It is an objective of the present invention to
5 provide a guide means for precisely aligning the LRM's
with corresponding mother board connectors during
insertion into a black box, thereby eliminating the
necessity of the LRM connectors to move incrementally to
self-align with the respective mother board connectors.

10 It is another objective to provide a guide means
which participates in removing heat from the LRM.

Embodiments of the present invention will now be
described with reference to the accompanying drawings in
which:

15 FIGURE 1 is a perspective view of a black box having
an array of LRM's therein, with one LRM removed therefrom
showing the tracks of the present invention;

FIGURE 2 is an elevation view of an LRM secured in
position in the black box, with the tracks secured to the
20 frame and shown in the LRM channels in phantom; and

FIGURE 3 is an enlarged view of the connector end of
a track exploded from the frame, the mother board, and the
flange of the mother board connector, with a nut to be
fastened on the end thereof upon assembly.

25 FIGURE 4 is an enlarged view of the forward track end
fastened to the framework.

FIGURE 5 illustrates an alternate embodiment of the
present invention with the tracks extending arcuately
inwardly to engage continuous channel bottoms along the
30 LRM under spring bias after LRM insertion.

Black box 10 includes a frame 12 to which is mounted
mother board 14 having an array of mother board connectors
16 mounted thereon side by side in a closely spaced array.
A plurality of line replaceable modules or LRM's 18 are
35 mounted in black box 10 likewise arranged in a closely
spaced side by side array, with each LRM having an LRM

1 connector 20 secured on a forward end 22 thereof in mated
engagement with a respective mother board connector 16.

A pair of track members 24 extend forwardly from ends
of each mother board connector 16 to the LRM-receiving
5 opening 26 of black box 10 and are fastened at first ends
28 to frame 12 near opening 26 and at second ends 30 to a
portion of frame 12 such as right angle members 32. Each
LRM 18 includes channel portions 34 along sides 36 thereof
at least at forward end 22 and at trailing end 38 along
10 which tracks 24 are disposed enabling LRM 18 to be
inserted into black box 10 therealong so that LRM
connector 20 is laterally and axially aligned with
corresponding mother board connector 16 upon full LRM
insertion. A lock member 40 is then rotated into a
15 position securing the LRM within the black box by means of
a lock tab 42 being rotated behind an end portion 44 of
LRM 18 as seen in Figure 2.

With particular reference to Figure 3, second end 30
of each track 24 is threaded to receive a nut 46 thereon
20 to be fastened securely to frame member 32. Prior to nut
46 being placed thereon, second end 30 is inserted through
hole 48 through flange 50 of metal shell 52 of mother
board connector 16, through hole 54 of mother board 14,
and through a large hole or slot 56 of frame member 32.
25 Connector hole 48 is precisely located in connector flange
50 to correspond with the locations of terminals 58 along
mating face 60 of the mother board connector, and is
precisely dimensioned with respect to the diameter of
track 24 so that track 24 may be inserted therethrough but
30 not permitted lateral movement therewithin. Connector
hole 48 may be counterbored to include a stop shoulder 62
cooperating with a stop shoulder 64 formed along second
track end 30 at a precise distance from the right angle
bend of first end 28, whereby when nut 46 is secured on
35 end 30 the track firmly engages connector stop shoulder 62

1 and constitutes the primary mechanical means for holding
mother board connector 16 to mother board 14. Prior to
assembly of tracks 24, the mother board connectors are
secured to mother board 14 by solder joints of their
5 terminals 58 to board circuit paths or in through-holes of
the board. Mother board hole 54 may be slightly larger
than the portion of track end 30 extending therethrough
and is aligned with connector hole 48. A slot 56 of frame
member 32 is located at each connector location and
10 extends in the direction of the array of mother board
connectors, so that when mother board 14 is mounted to
frame members 32 a portion of the slot is aligned with
holes 48, 54 to receive the threaded portion of track end
30 therethrough to be fastened with nut 46. In this
15 embodiment tracks 24 when fastened provide the means for
mounting the mother board connectors to the mother board,
and further provide the means for mounting the mother
board within the black box. It is easier to assemble the
mother board with the array of connectors thereon, and the
20 pairs of track members to the framework to comprise an
assembly which is then placed into the outer cover of the
black box and secured therein. Also it may be desirable
for the black cover of the black box to be removable
therefrom to enable access to the back surface of the
25 mother board for repair thereof without first requiring
removal of all LRM's and the framework from the black box
to gain access to the mother board.

With particular reference to Figure 4, first track
end 28 is inserted into hold 65 of frame 12 until stop
30 shoulder 66 engages frame 12 after which nut 68 is
fastened onto the threaded end portion. Stop shoulder 66
is precisely located with respect to right angle bend 70
so that when seated against frame 12 the main track
portion is parallel to the opposing track and

1 perpendicular to mating face 60 of mother board connector
16, so that LRM 18 is axially aligned with connector 16.

An alternate embodiment of the present invention is
shown in Figure 5. LRM 80 includes continuous channels 82
5 along side surfaces 84 thereof. Track members 86 mounted
in black box 88 have a slight inwardly arcuate
configuration 90 beginning just above mother board
connector 92. Upon insertion of LRM 80 therealong the
bottom surfaces of channels 82 engage inward
10 configurations 90 and deflect them outwardly. After LRM
80 is secured in black box 88, the spring characteristics
of the deflected track portions provides continuous
intimate contact with the bottom surfaces of channels 82
substantially their entire length, which establishes a
15 good thermal connection between tracks 86 and LRM 80.
Thus tracks 86 facilitate the dissipation of heat from the
LRM during in-service use. This benefit can be enhanced
by forming tracks 86 from tubing and coupling the ends
thereof to a fluid circulation system (not shown) to
20 enable cooling of the LRM by a conventional refrigerating
system. Aluminum tubing could be used, with aluminum
having good heat conductivity characteristics and enough
spring strength to be useful in this embodiment.

While it is preferred that tracks be formed of
25 cylindrical rods or tubes, other cross-sectional
configurations could be used such as a V-shape with LRM
channels being V-grooves. Other fastening means could be
used to secure tracks to the black box framework. Still
other variations may be made to the embodiments shown
30 without departing from the spirit of the invention or the
scope of the claims.

CLAIMS:

1 1. A system for guiding a module during
insertion into an electronic control unit enabling
axial movement of the module towards a respective
portion of a remote panel mounted in a framework
5 of the control unit, said movement being in precise
lateral and axial alignment therewith, the module
being of the type having an electrical connector on
its leading end matable with a corresponding
electrical connector mounted to said panel portion,
10 characterized in that:
a pair of opposed elongate track members each
have a first end and a second end both said
first and second ends are adapted to be fastened
to the framework, said first end fastened to the
15 framework forwardly of the panel portion and
said second end inserted through a locating aperture
of the panel portion and fastened to the
framework portion therebehind, said first ends
being fastened so that said pair of track members
20 extend in parallel forwardly from said panel portion
and perpendicular thereto; and
a module has opposed side surfaces
associated with said pair of track members and
extends from a leading end to a trailing end of
25 said module, each said side surface including
channel portions therealong at least adjacent said
leading end and said trailing end cooperating
with a respective said track member, whereby said
module is placeable between said track members
30 with said track members disposed in close engagement
with bottom surfaces of said channels and is movable
along said pair of track members toward the

1 respective panel portion and is laterally and axially
aligned therewith upon being moved adjacent thereto.

2. A guide system as set forth in claim 1 further
characterized in that said first end includes a
5 portion extending outwardly from a right angle bend and
further includes a stop shoulder engageable with a
surface of the framework about an aperture
through which the end portion of said first end
extends to be fastened, whereby said track member is
10 spaced a selected distance inwardly from the framework.

3. A guide system as set forth in claim 1 further
characterized in that said second end includes a stop
shoulder engageable with a forwardly facing stop
15 shoulder associated with and peripherally around said
locating aperture therethrough through which said
second end extends to be fastened to the framework
portion, whereby said track members hold the
panel portion to the framework.

20 4. A guide system as set forth in claim 1 further
characterized in that said panel is a printed circuit
board having circuit means thereon and a first
electrical connector is disposed precisely on the
portion thereof with first electrical terminals
25 connected to the circuit means of the board; and said
module includes electrical components therewithin
connected to second electrical terminals in a second
electrical connector secured at a forward end of
said module to be mated with said first electrical
30 connector, said second electrical terminals being
appropriately aligned with said first electrical terminals
when said module is aligned by said pair of
track members with the panel portion, enabling
appropriate electrical engagement therebetween when said
35 leading end of said module is moved adjacent

1 said first connector mounted on said panel portion.

5. A guide system as set forth in claim 4 further
characterized in that said first connector includes
5 flanges extending over said locating apertures
and including holes aligned with said locating
apertures through which said track members
extend prior to being fastened.

6. A guide system as set forth in claim 4 wherein
10 said track members are hollow tubes enabling fluid to
be circulated therethrough to dissipate heat from said
module during in-service use thereof in an electrical
system.

7. A system for guiding a module during insertion
15 into an electronic control unit substantially as described
with reference to Figures 1 to 4 or 5 of the drawings.

Amendments to the claims have been filed as follows

- 1 1. A system for guiding a module during insertion
into an electronic control unit enabling axial move-
ment of the module towards a respective portion of a
remote panel mounted in a framework of the control
5 unit, said movement being in precise lateral and axial
alignment therewith, the module being of the type
having an electrical connector on its leading end
matable with a corresponding electrical connector
mounted to said panel portion to establish electrical
10 connections between the respective electrical
terminals thereof, the control unit including a pair
of opposed elongate track members, each having a first
end and a second end, adapted to be fastened to the
framework, the first end being fastened to the
15 framework forwardly of said panel portion and the
second end being inserted through a locating aperture
of the panel portion and being fastened to the
framework portion therebehind, the first ends being
fastened so that the pair of track members extend in
20 parallel forwardly from the panel portion and
perpendicular thereto, and the module having opposed
side surfaces associated with the pair of track
members and extending from a leading end to a trailing
end of said module, each side surface including
25 channel portions therealong at least adjacent the
leading end and the trailing end cooperating with a
respective track member, whereby the module is
placeable between the track members with the track
members disposed in close engagement with bottom
30 surfaces of the channels and is movable along the pair
of track members toward the panel portion and is

1 laterally and axially aligned therewith upon being
moved adjacent thereto, said panel-mounted connector
having flanges extending over the locating apertures
and holes precisely positioned with respect to
5 locations of the terminals therein, and said holes
being aligned with the locating apertures through
which the track members extend prior to being fastened
to the framework portion thereby assuring that said
second ends of the track members are disposed in a
10 precise position with respect to the terminals of the
panel-mounted connector, whereby the leading end of
the module is aligned with the panel-mounted connector
upon being moved adjacent thereto, and the module
connector is precisely aligned with the panel-mounted
15 connector at least immediately prior to mating
enabling appropriate electrical engagement between the
terminals thereof.

2. A system as claimed in claim 1, wherein said
first end includes a portion extending outwardly from
20 a right angle bend and a stop shoulder engageable with
a surface of the framework about an aperture through
which the end portion of said first end extends to be
fastened, whereby the track member is spaced a
selected distance inwardly from the framework.

25 3. A system as claimed in claim 1 or 2, wherein
said second end includes a stop shoulder engageable
with a forwardly facing stop shoulder associated with
and peripherally around the locating aperture through
which said second end extends to be fastened to the
30 framework portion, whereby the track members hold the
panel portion to the framework.

1 4. A system as claimed in claim 1, 2 or 3, wherein
the track members are hollow tubes enabling fluid to
be circulated therethrough to dissipate heat from the
module during in-service use thereof in an electrical
5 system.

5 5. A system as claimed in claim 1, 2, 3 or 4,
wherein the panel is a printed circuit board including
a plurality of circuit means thereon to which the
terminals of the panel-mounted connector are
10 electrically connected.

6. A system as claimed in any one of the preceding
claims, wherein each of the pair of track members is
slightly inwardly arcuate therealong and the track
members are deflected outwardly by the bottoms of the
15 channels of the module during insertion, and
thereafter remain deflected and engage the channel
bottoms under spring bias assuring substantial surface
contact therewith and a good thermal connection
therewith, facilitating heat dissipation from the
20 module.

7. A system for guiding a module during insertion
into an electronic control unit substantially as
hereinbefore described with reference to Figures 1 to
4 or Figure 5 of the accompanying drawings.